Instituto Superior de Economia e Gestão
UNIVERSIDADE TÉCNICA DE LISBOA
DESDE 1911

MESTRADO EM FINANÇAS

TRABALHO FINAL DE MESTRADO

DISSERTAÇÃO

LEARNING EFFECT: WHAT SOURCES OF KNOWLEDGE DETERMINE SPIN-OFFS PERFORMANCE?

CRISTINA ALEXANDRA GRILO LOPES

ORIENTAÇÃO:

PROFESSORA ANA ISABEL ORTEGA VENÂNCIO

SETEMBRO – 2012

ABSTRACT

Previous literature suggests that new firms established by entrepreneurs that previously worked in the same industry, also known as spin-offs, perform better than other entrants. In this study we try to explain their superior performance based on the learning effect theory. We suggest that the founders of spin-offs learn and transfer knowledge from their parent firm to their new ventures, affecting ventures survival and growth. In order to analyze this, we start by categorizing and measuring different types of knowledge accumulated by the founder while working in the parent firm. We focus only in market and technological knowledge. Then, we test how these specific knowledge attributes affect spin-offs' performance.

To perform our analysis, we draw on two rich datasets: matched employer-employee database and one financial database. With these databases, we have access to micro-level data on firms and founders combined with firm's financial data. As individuals and firms are cross referenced by a unique identifier, we can trace the mobility of workers across firms and their career histories.

Our results suggest that, in the opposite of what we were expecting, only technological knowledge has a significant impact on spin-offs' performance in terms of survival and growth, increasing their probability of surviving by 8,13% and increasing their growth by 10,5%. In the other hand, market knowledge has no significant impact on spin-off's performance either in terms of survival or growth.

***JEL* classification:** M13, L26

Keywords: Spin-off, Knowledge Transfer, Knowledge Accumulation, Performance, Survival, Growth

RESUMO

A literatura sugere que novas empresas criadas por indivíduos que anteriormente trabalhavam no mesmo sector, denominadas de *spin-offs*, apresentam um desempenho superior relativamente às outras. Este estudo tem como objectivo explicar a elevada performance dos *spin-offs* com base na teoria do efeito de aprendizagem (*learning effect theory)*. Na sequência dessa teoria, sugere-se que os fundadores de *spin-offs* aprendem e transferem conhecimento da sua empresa-mãe, que por sua vez irá afectar o seu desempenho económico em termos de sobrevivência no mercado e crescimento. De modo a analisar o impacto da aprendizagem e transferência de conhecimento nos *spin-offs*, começou-se por categorizar e medir diferentes tipos de conhecimentos acumulados pelo fundador enquanto trabalhava na empresa-mãe. Este estudo apenas se focou nos conhecimentos de mercado e conhecimentos tecnológico. De seguida, avaliou-se de que forma esses conhecimentos específicos afetam o desempenho dos *spin-offs*.

A análise baseou-se em duas bases de dados: Quadros de Pessoal e outra base que comtempla dados financeiros. Utilizando ambas as bases de dados foi possível obter a informação que associa empresas e fundadores a dados financeiros das respectivas empresas. Como os indivíduos e as empresas são cruzados e identificados por um identificador único, foi possível analisar a mobilidade dos trabalhadores entre empresas e sua carreira.

Os resultados sugerem que, ao contrário do que se estava à espera, apenas o conhecimento de tecnologia tem um impacto significativo no desempenho dos *spin-offs* em termos de sobrevivência e crescimento*,* aumentando a probabilidade do *spin-off* sobreviver no mercado em 8,13% e aumentanto a sua taxa de crescimento em 10,5%. Por outro lado, o conhecimento de mercado aparentemente não tem impacto

significativo no desempenho dos *spin-offs*, tanto em termos de sobrevivência como em termos de crescimento.

Classificação do JEL: M13, L26

Palavras-chave: *Spin-off,* Transferência de conhecimento, Acumulação de Conhecimento, Desempenho, Sobrevivência, Crescimento

ACKNOWLEDGMENTS

I would like to express my gratitude to my research advisor, Prof. Ana Venâncio, for the availability shown throughout its development. Her commitment, guidance and advice were most useful.

I am also grateful to a special person, Guilherme, for his constant concern, encouragement and for being always present. His personal support enables me to complete this work.

Finally, I would like to thank the Portuguese Ministry of Employment and Social Security and Gabinete de Estratégia e Planeamento (GEP) for giving me access to the matched employer-employee data. All errors remain my own. Views expressed are those of the author and do not necessarily reflect those of any branch or agency of the Government of Portugal.

TABLE OF CONTENTS

LIST OF TABLES

I.INTRODUCTION

Two empirical facts are unequivocal in the entrepreneurial literature. First, the vast majority of the successful entrepreneurs were previously employed (Burt, 2000; Gompers, Lerner and Scharfstein, 2005). Second, ventures established by entrepreneurs that previously worked in the same industry (spin-offs) perform better than other entrants (Klepper, 2001, 2007; Colombo, Delmastro and Girilli, 2004; Astebro and Bernhardt, 2005).

Although several theories have been appointed to explain spin-offs superior performance, [1] in this paper we will focus on the most cited perspective, the learning effect theory. This theory suggests that resources such as routines and knowledge are transferred from the incumbent firm to the new entity (Carroll, 1984; Hannan and Freeman, 1986). While working, the founders learn and observe the organization structure of the incumbent firm, acquire the relevant knowledge on the product and technology but also on the markets and its key players. When starting their own firms, these entrepreneurs will use their accumulated knowledge and they will mirror and improve the models and routines that they are familiar with (Dahl and Reichstein, 2010).

As suggested by previous studies, founder's knowledge endowments and prior experiences are thus crucial for the fate of the new venture.

[1] Other theories include: the institutional effect (Higgins and Gulati, 2003; Ferreira, Tavares, Hesterley and Armagan, 2006), timing effect (Klepper, 2001; Koster, 2004) and more recently the self-selection effect (Chatterji, 2009; Bazzazian, 2012).

Nevertheless, it is less clear empirically what structural skills and knowledge are responsible for the spin-offs superior performance. While there has been a growing research on understanding the link between prior employer characteristics and spin-off success, this central question remains partially unanswered and therefore it will be the focus of this study. Studies have analyzed the size,[2] the age (Klepper and Sleeper, 2005; Ferreira, Tavares, Hesterley and Armagan, 2006), the degree of prominence (Burton, Sorensen and Beckman, 2002) and the performance (Dahl and Reichstein, 2005, 2006, 2010; Agarwal, Echambadi, Franco and Sarkar, 2004; Eriksson and Kuhn, 2006) of the incumbent firm. Others highlight the importance of founder characteristics, such as tenure[3] (Dahl and Reichstein, 2005, 2006, 2007 and 2010) on spin-offs superior performance. However, only technological knowledge and innovation has been empirically analyzed (Chatterji, 2009; Andersson, Baltozopoulos and Loof, 2011).

In this paper, we empirically evaluate the roots of knowledge accumulation, and contribute to the learning effect theory by defining the exact mechanisms that underlie spin-off's superior performance. In order to do so, we start by categorizing and measuring different types of knowledge accumulated by the founder while working in the parent firm. Then, we evaluate which knowledge is more likely to affect venture performance by taking into account several mediator factors, such as prior employer's characteristics (i.e. age, size and performance) or founders' characteristics

[2] See, e.g., Sorensen and Phillips (2004); Klepper and Sleeper (2005); Klepper and Thompson (2005); Klepper (2009); Ferreira et al., (2006); Parker (2009); Elfenbein, Hamilton and Zenger (2010).
[3]We define tenure as the length of time the founder worked in the previous employer.

(i.e. age, education, gender, parent industry experience, entrepreneurial experience and regional experience).

To perform our analysis, we draw on two rich datasets: matched employer-employee database (Quadros de Pessoal) and a financial database. With these databases, we have access to micro-level data on firms and founders combined with firm's financial data. Our data gives us detailed information not only on founders and their background history but also firm's R&D investments and marketing expenses. As individuals and firms are cross referenced by a unique identifier, we can trace the mobility of workers across firms.

Our results suggest that technological knowledge accumulated and transferred from the parent firm has a significant and positive impact on spin-offs' performance in terms of survival and growth, increasing their probability of surviving by 8,13% and increasing their growth by 10,5%. In contrast, we can infer from our results that market knowledge has no significant impact on spin-off's performance in terms of survival and growth.

Implications of this research for policy-makers and academics are significant. This is important for policy makers, who wish to enhance entrepreneurial activity and for researchers to gain insight about the impact of the learning effect on performance and more specifically, to understand which knowledge triggers successful ventures. Several institutions, for example universities and other governmental agencies, may as well benefit from the indication of which kind of knowledge gap is important to fill to foster high-growth businesses. This makes conclusions with regard to the effects of knowledge transfers to spin-offs very relevant.

The remaining sections of this paper are organized as follows. The following section reviews the literature on spin-offs. Then, in section III we exhibit our theory and hypotheses. In section IV, we describe the dataset and how it was constructed. The empirical methodology and results are described in section V. Finally, we present our conclusions in section VI.

II. LITERATURE REVIEW

Spin-offs (or spin-outs) [4] have attracted a large attention in the entrepreneurial literature. They have been studied in several set of industries like the tire industry (Buenstorf and Klepper, 2009), medical device industry (Chatterji, 2009), laser industry (Klepper and Sleeper, 2005), automobiles (Klepper, 2002), and disk drives (Agarwal et al., 2004). In these studies, spin-offs are the most successful type of entrants outperforming de novo entrants and diversifying firms. They grow faster and have higher survival rates.[5] In fact, spin-offs play an important role on job ccreation and economic growth but also in the development of industries (Klepper, 2002; Klepper and Sleeper, 2005; Agarwal et al., 2004).

A number of theories have been advanced to explain why some employees exit their parent firm to start their own firm. Spin-offs either emerge due to technological innovations/ business opportunity (Wiggins, 1995), or due to employee's frustration with the parents' organizational inertia.[6] Very often employee's frustration arise because their ideas for an innovation or a new sub-market are rejected by the parent firm (Klepper and Sleeper, 2005), or they simply become unhappy with their careers prospects (Eriksson and Kuhn, 2006). Klepper and Thompson (2006) add that spin-offs occur when

[4] More recently, some studies have adopted the term spin-outs to distinguish between employees spin-offs and corporate spin-offs. See for example, Agarwal et al., (2004). Also, the literature distinguishes between intra-industry spin-offs and inter-industry spin-offs. While intra-industry spin-offs are firms founded by ex-employees of parent firms in the same industry, inter-industry spin-offs are spin-offs established in a different industry. In this study, we will refer to intra-industry spin-offs by simply spin-offs .

[5] Eriksson and Kuhn (2006); Klepper (2001, 2002); Agarwal et al. (2004); Klepper and Sleeper (2005); Klepper and Thompson (2006); Dahl and Reichstein (2010).

[6] See, e.g., Garvin (1983); Cooper (1985); Klepper (2001); Phillips (2002).

disagreements between the parent firm and employees are of sufficient magnitude to justify the cost of forming a new firm.

II.1 THEORIES ON SPIN-OFFS PERFORMANCE

Given that spin-offs outperform other entrants, previous literature has devoted a considerable amount of effort in understanding the main determinants of such superior performance. Among several explanations, we can summarize the following theories: (1) knowledge accumulation effect (learning effect); (2) institutional effect (Higgins and Gulati, 2003; Ferreira et al., 2006); (3) timing effect (Klepper, 2001; Koster, 2004); and (4) self-selection effect (Chatterji, 2009; Bazzazian, 2012).

The most cited explanation is the learning effect perspective. This perspective argues about founders superior knowledge endowments (Agarwal et al., 2004; Dahl and Reichstein 2006, 2010). Founders accumulate not only codified knowledge, available in memos, reports or technical specifications but also tacit knowledge (Helfat and Lieberman, 2002; Agarwal et al., 2004) generated by learning by doing (Arrow, 1962) or learning by observing (Nonaka, 1994) in the course of their previous employment. Also, they learn the routines and skills while being employed at an incumbent firm, which become useful for them and eventually lead to superior venture performance.[7] As evidence of the learning effect perspective, spin-offs concentrate in younger industries and tend to locate in close proximity to their parent firm

[7]Shane (2000); Klepper (2001); Dahl and Reichstein (2010); Dahl and Reichstein (2005); Dahl, Pederson and Palum; Baptista, Karaoz and Mendonça (2007).

(Sorenson, 2003). Detailed knowledge and social connections tend to be immobile and unequally distributed across geographical space (Dahl, Pederson and Palum), therefore locating near the parent firm facilitates the knowledge transfer to the founder. Moreover, in younger industries, knowledge is more likely to be embodied in human rather than physical capital (Garvin, 1983).

Thus far, the focus of the previous studies on learning effects has been in the transfer of industry specific knowledge, they have identified several knowledges but none of the studies have tested empirically their effects.[8] Previous literatures suggest that spin-offs are more successful than other entrants because they take advantage of various industry specific knowledge that founders acquire while being employed at their parents.[9] Since spin-offs' resources are directly related to the focal industry of their parents (Agarwal et al., 2004), these ventures have superior capabilities to mobilize and use their resources (Koster, 2004). Several industry specific knowledge are transferred to the new entity, for example: personal networks (Eriksson and Kuhn, 2006) and market knowledge (Klepper and Sleeper, 2005; Agarwal et al., 2004). The latter includes marketing knowledge on distribution channels, marketing techniques and expertise, and customer demand (Uzunca, 2011), as well knowledge about suppliers and competitors (Helfat and Lieberman, 2002).

[8] Except Andersson et al., (2011), that have empirically analyzed technological and innovation knowledge.
[9] See, e.g., Klepper (2001); Helfat and Lieberman (2002); Koster and Wissen (2003); Klepper and Sleeper (2005); Dahl and Reichstein (2005); Balconi and Fontana (2011); Bazzazian (2012).

Knowledge on R&D strategies, innovation, products (Klepper and Sleeper, 2005) and technologies (e.g. knowledge on production processes and business processes) (Agarwal et al., 2004; Chatterji, 2009; Andersson et al., 2011) also appear to be transferred to the new entries. Particularly, innovative parents firms (with significant investments in R&D), tend to stimulate entrepreneurs of higher quality and spun off ventures with longer survival prospects (Klepper 2001; Andersson et al., 2011). Balconi and Fontana (2011) adds that spin-offs from innovative parents are more likely to innovate as well.

Parents' organizational routines, blueprints, strategies and organizational forms can also be transferred to the new firms.[10] In fact, spin-offs maintain a close contact and informal ties with their parent firms. This allows spin-offs to acquire resources, creating an advantageous position over the other start-ups (Helfat and Lieberman, 2002). These informal relations happen, for example, through daily telephone calls, visits to old colleagues and common activities among firms (Uzunca 2011). Consequently, spin-offs usually resemble very closely their parents firms.

Some studies even go further by comparing spin-offs to parasites, that feed from the innovations and knowledge of their parents (Klepper and Sleeper, 2005; Klepper and Thompson, 2006). In contrast, others see spin-offs as the engine of innovation, compensating for the incumbents inertia (Klepper and Thompson 2006; Ferreira et al., 2006). A third view suggests that spin-offs differentiate themselves from their parents, by adopting and improving

[10] See, e.g., Klepper (2001, 2002); Carroll et al. (1996); Helfat and Lieberman (2002); Phillips (2002); Aldrich and Wiedenmayer (1993).

parent's routines. Thus, they do not copy but simply adapt and reform routines based on their experience (Dahl and Reichstein, 2006). To sum up, the learning effect theory suggests that spin-offs superior performance is due to the transfer of knowledge (in innovation/technological, marketing and organizational) from the parent firm to the new entity.

Alternatively, the institutional theory suggests that parent firm provides not knowledge but social intangible resources, such as reputation and legitimacy (Higgins and Gulati, 2003) as well as credibility, which in the end affect venture performance. The parent firm signals the quality of the new venture, leading the market to extrapolate the same qualities and capabilities from the parent to the spin-off (Ferreira et al., 2006).

A third theory suggests that spin-offs' superior performance is due to a better time management, either due to an early mover advantage (Klepper, 2001) or a longer maturing phase (Koster, 2004) to evaluate the decision to enter into the market. As founders are still employed in the set-up period, spin-offs will only come to life when the idea is profitable and well matured (Koster, 2004).

More recently, studies have been arguing that spin-offs success does not result from an inheritance process but from a self-selection mechanism where the more talented and endowed employers with higher innate abilities choose to leave their previous employer to start they own business (Chatterji, 2009). The best and brightest employees of the incumbent firms are systematically selected into spin-offs and as a result the performance of their new venture will be correlated with their innate abilities (Bazzazian, 2012).

II.2 EMPIRICAL RESULTS ON SPIN-OFFS PERFORMANCE

Closely related to the learning perspective theory presented above, a growing stream of the literature investigates empirically and or analytically the effects of parent firm characteristics (e.g. age, size, prominence[11] and performance) and founder characteristics (e.g. educational background and tenure) on spin-offs performance. These characteristics function as mediator factors on the process of knowledge accumulation.

Entrepreneurs with longer tenure (and hence with longer experience) are better endowed to adapt, improve and reflect the knowledge gained in the parent company (Dahl and Reichstein, 2005; 2006; 2007; 2010). Also, highly educated founders with diverse experiences have the required "absorptive capacity" to understand and produce more technical knowledge (Balconi and Fontana, 2011).[12]

Older, better performing and prominent parent firms facilitate the knowledge accumulation process. In fact, older firms generate greater knowledge (Klepper and Sleeper, 2005) and have higher network benefits and higher social capital advantages (i.e. reputation, legitimacy, and status) (Ferreira et al., 2006) that the potential founders can draw on. On the other hand, founders from prominent firms have both information and reputation advantages and easier access to resources. The degree of prominence of

[11] Prominence is the number of spin-offs generated by parent firm through employee departures, also known as, the spin-off rate.
[12] According to Burton, Sorensen and Beckman (2002), the main source of venture quality lies in the prior accomplishments of the founders, particularly their career history, experiences and skills.

parent firms also positively affects the quality of innovation of the new firms (Burton et al., 2002). Additionally, spin-offs from surviving parents perform remarkably better than other entrants (Dahl and Reichstein, 2005, 2006). Smarter parents are likely to give birth to smarter progenitors (Agarwal et al., 2004) and healthy parents generate spin-offs with longer growth and survival prospects (Eriksson and Kuhn, 2006).

Another characteristic widely study in the literature is the parents size. Some authors argue that larger firms have the capacity to introduce greater knowledge (Klepper and Sleeper, 2005; Klepper and Thompson, 2005; Klepper, 2009), generate more unused ideas that spin-offs can exploit,[13] and have a more extensive networks (Ferreira et al., 2006). However, the majority of the studies argue that smaller firms allow potential entrepreneurs to be more generalists, acquire more heterogeneous information and have easier access to valuable resources and contacts outside the firm[14] (Gompers et al., 2005; Dobrev and Barnett, 2005). The division of labor in small firms is less formalized, which allows potential entrepreneurs to obtain diverse set of skills on a variety of activities (Parker, 2009; Elfenbein et al., 2010).

In the next section, we will present our theory and hypotheses exploring the importance of resources and, more particularly, the importance of

[13] See, e.g., Henderson (1993); Klepper (2001); Gompers et al. (2005); Audretsch et al. (2006).

[14] As Garicano and Hubbard (2003) argue, division of labor in firms becomes more definite with firm size. In small firms, in which the division of labor is less formal, employees normally execute less specialized tasks than large firms, where employees are mainly concerned with one specialized task hindering entrepreneurs from gaining an overview of the whole production process (Koster, 2004; Tsuchiya, 2006; Parker, 2009).

knowledge in the performance and success of new entries and, therefore, in spin-offs. We will also discuss the process of knowledge transfer/learning as well the importance of some of the different kinds of knowledge in firm's performance such as technological and marketing knowledge.

III. THEORY AND HYPOTHESES

New entrants arrive to the market with initial resources that derived from their historical antecedents. According to the resource based view, firm resources include assets, capabilities, organizational processes, firm attributes, information, and knowledge. Basically, firm resources can be seen as the strengths that firms can use to conceive and implement their strategies that improve its efficiency and effectiveness (Barney, 1991). More formally, they can be separated into tangible and intangible resources: physical assets such as capital, buildings and codified knowledge are tangible resources; organizational routines, human resources and tacit knowledge are examples of intangible resources (Koster, 2004).

Followers of the resource based view generally agree that the most strategically important resource is knowledge/intangible assets (Osterloh and Frey 2000). Entrants bring with them resources and, more specifically, knowledge and skills embodied in their founders and gained at the parent firm that are likely to influence the firm's performance and success in the long run (Helfat and Lieberman, 2002).

The process by which new firms, and more specifically spin-offs, bring with them knowledge gained at the parent firm involves two mechanisms: learning at the parent firm and/or transfer knowledge from the parent firm. According to Huber (1991), learning is defined as the acquisition of any knowledge about the industry in which a firm intends to compete, that is, firm specific knowledge acquired by the founder while working at their parent firms. When ex-employees founders use this specific knowledge in their new ventures, resources of the parent firm are unintentionally shared with the newly

developed firm (Koster, 2004). In contrast, knowledge transfer is a process which consists of exchanging, receiving, and using external knowledge (Van Wijk, Jansen, and Lyles, 2008). It manifests itself through changes in the knowledge or performance of the recipient units (that is, the organization that receives the external knowledge). Thus, knowledge transfer can be measured by measuring changes in knowledge or changes in performance (Argote and Ingram, 2000). According to McGrath and Argote (2001), knowledge is embedded in the three basic elements of organizations — members (the human components of organizations), tools (the technological component, including both hardware and software), and tasks (that reflect the organization's goals, intentions, and purposes) — and the various sub-networks formed by combining or crossing the basic elements. As the greater the similarity between pre-entry firm resources and the required resources in an industry, the greater the likelihood that the firm will survive and prosper (Helfat and Lieberman, 2002), we argue that the more similar the number of elements across the tasks between organizations, the greater the likelihood of the transfer (Thorndike, 1906).

The speed and quality of the knowledge transfer/learning is determined by the ability to communicate and share the knowledge or skill (Argote, Ingram and Moreland, 2000), the strength of the tie (Hansen, 1999), the motivation of the agent of the transfer[15] (Osterloh and Frey, 2000), the pre-

[15] Employees are motivated intrinsically (if an activity is undertaken for one's immediate need satisfaction, that is, if the work content itself all compensation) as well as extrinsically (if they are able to satisfy their needs indirectly, especially through monetary compensation). Intrinsic motivation is crucial when tacit knowledge between organizations must be transferred and enables the transfer of tacit knowledge under conditions in which extrinsic motivation fails (Osterloh and Frey, 2000).

entry experience of the founder (Cohen and Levinthal, 1990; Zander and Kogut, 1995) and the type of knowledge to transfer. Strong ties between the parent and spin-off facilitate communication promoting knowledge acquisition, particularly when knowledge is not codified (Hansen, 1999). In fact, the more easily a specific knowledge or skill can be communicated and shared, the shorter the times to transfer (Argote, Ingram and Moreland, 2000). According to Zander and Kogut (1995), the accumulation of experience in a sector or activity facilitates the communication process and the understanding of the relevant knowledge. This ease, in turn, should reduce the cost of acquiring related capabilities and speed the time to transfer. So, skills are more quickly transferred the more they share elements with already acquired knowledge. Also, the critical knowledge that allows a firm to function is tacit that is acquired largely through employees experience in the course of their previous employment (Cohen and Levinthal, 1990). Finally, the speed of knowledge transfer differs according to the type of knowledge. While codified knowledge is possible to store in a mechanical or technological way, like in handbooks or information systems, a firm's tacit knowledge is mostly stored only in human beings (Haldin-Herrgard, 2000), as well embedded in firm's routines (Nelson and Winter, 1982). Therefore, codified knowledge is more easily transferable and more easily to assimilate than tacit knowledge (Argote and Ingram, 2000). Nevertheless, the role of tacit knowledge is essential as organizational core competency requires this knowledge to put in practice the codified knowledge (Haldin-Herrgard, 2000).

Various kinds of knowledge can be learned or transferred from parent firms to spin-offs.

Klepper and Sleeper (2005), Agarwal et al. (2004), Franco and Filson (2006) and Chatterji (2009) suggest that spin-off firms acquire valuable technological and market related knowledge from their incumbent firms. Employees accumulate technical knowledge like for example knowledge about the products and the production process that can be used as input for a new firm (Koster, 2004). Technological knowledge can be defined as those knowledge that mediate between inputs and outputs (process technology) and/or that create new products or services (product technology) (Tushman and Anderson, 1986). This kind of knowledge is essential for a firm in the sense that it forms the bases of innovation reflecting firm's ability to generate new scientific discoveries and technological breakthroughs (Agarwal et al., 2004). So, it is expected that a firm's probability of surviving is increasing in its technological know-how (Agarwal et al., 2004; Franco and Filson, 2006). The more technical knowhow the firm has, the longer it will survive. Therefore, this kind of knowledge is essential for new ventures performance:

H1: The acquisition and the transfer of technological knowledge from the parent firm increase the performance of spin-offs.

Employees also accumulate market-related knowledge (e.g. customer needs, distribution methods and channels, selling methods, marketing practices, network of suppliers, commercialization of a product, operation of the market, etc.), which is essential in daily operation of a business

(Bazzazian, 2012). Marketing relatedness manifests itself, for example, (i) when a high percentage of an entrant's initial sales come from existing channel customers or end customers of the parent firm (Biggadike, 1976) or (ii) when the entrant benefits from existing parent firms programs and famous brand names (Biggadike, 1976). Besides enabling firms to fulfill better sales figures through the application of better marketing strategies, this kind of knowledge also forms the bases of marketing-based differentiation indicating whether a firm can commercialize technological innovations before competitors do (Agarwal et al., 2004). If founders of spin-offs inherit this kind of knowledge, it is expected that they are more familiar with the marketing skills needed to compete in the entered market and hence, more capable to survive and growth compared to other entrants. Therefore, we expect that:

H2: The acquisition and the transfer of market knowledge from the parent firm increase the performance of spin-offs.

Technological and market knowledge are both important for the success of a new venture. It will be a poor plan of entry if a firm either misses technical knowledge or marketing knowledge on how to design, price, service, and sell the products (Biggadike, 1976). Nevertheless, it is important to clarify which of these two kinds of knowledge (technological and market knowledge) have more impact on the performance of spin-offs. Chatterji (2009) finds little evidence that technical knowledge gained at the parent firm affects the superior performance of new spawns in the medical device sector. Instead, he

argues that nontechnical types of knowledge acquired at the parent firm help spawns in the regulatory process, marketing to physicians, and identifying profitable market opportunities to pursue leading in this way to a spawns' superior performance. Also, Bazzazian (2012) suggest that knowledge related with marketing and commercialization of a product is more important for success than technological knowledge. In fact, he suggests that new firms have higher demands for commercial and market oriented activities than for more technical and R&D related activities.

Technological knowledge allows firms to create new products or services, and to generate new scientific discoveries and technological breakthroughs. Therefore, this knowledge is more likely to be tacit and hence more difficult to transfer. In the other hand, marketing knowledge is mainly held in the form of codified knowledge available in strategy reports, being more easily and faster to transfer and assimilate than technological knowledge. So, in the short-run, market knowledge is more accessible and easier to learn than technological knowledge. In addition, if market knowledge is more accessible in the short-run than technological knowledge, we can argue that this kind of knowledge will have a higher impact on the entry strategy of the new venture as well in their development in their first years.

Although it is important that spin-offs acquire/ learn technological knowledge from the parent firm, it is even more important that they use this kind of knowledge in order to differentiate themselves from the parent firm (Klepper and Sleeper, 2005) by innovating. Most innovations introduced by spin-offs are considered to be incremental at the beginning. An incremental

innovation is defined as a product or service attempting to serve customers needs already being served by existing products but with a new technology or method (Biggadike, 1976). Entrants with an incremental innovation face the tasks of developing the manufacturing processes for their product and attaining an acceptable level of product performance.[16] According Biggadike (1976), it takes longer to establish a new business based on an incremental innovation but the performance of such a business is better in the long-run. Thus, an incremental innovation allows spin-offs to build a better business in the long-run and, in this sense, to have a better long-term performance. As we mentioned before, technological knowledge forms the bases of innovation of a firm but has lower impact in short-term performance relatively to market knowledge. Nevertheless, its contribution to firms' long-term performance is vital. Therefore, we suggest the following hypothesis:

H3: In the short-term, market knowledge has more impact on spin-offs performance than technological knowledge.

In the next section, we will describe data that it will be use to test these hypotheses.

[16] In contrast, entrants with a similar offering can learn from existing processes or, even better, buy fully developed equipment and inputs from experienced suppliers (Biggadike, 1976).

IV. DATA AND DESCRIPTIVE STATISTICS

We combine two rich datasets: a matched employer-employee database, 'Quadros de Pessoal' (QP) and SCIE (Simplified Corporate Information).

The matched employer–employee dataset is a mandatory survey submitted annually to the Portuguese Ministry of Employment and Social Security by firms with at least one employee. The dataset collects information on an average of 207,000 firms and two million individuals per year, covering virtually all employees and firms in the Portuguese private sector from 1986 to 2009. As individuals and firms are cross referenced by a unique identifier, the database makes it possible to identify spin-offs and trace the mobility of entrepreneurs across firms and match founders with their ventures' characteristics. The database has complete information at the individual and firm level. At the firm level, the following data are available: year of creation, location, size, 4 digit-code industry and number of establishments. At the individual level, the database contains the following information: gender, age, education and occupation.

The main drawback of the previous database is its lack of financial information. To overcome this limitation, we use SCIE database. SCIE is a mandatory survey that collects year-end data on approximately 655 accounting variables, giving us detailed information on the performance and costs of the parent firms and spin-offs. The SCIE was introduced in 2005 to substitute IHE and to assure the reporting obligations of firms to different entities (Ministry of Justice, Ministry of Finance, Statistics Portugal (INE),

and Portugal Central Bank). From these databases we retrieve information on R&D investments and marketing expenses and other financial information from the parent firms and start-ups. An exact match between both financial datasets (IHE and SCIE) with QP was provided by INE.

From the QP data, we select all start-ups established in 2007. Then, for each start-up, we identify their founder and their background history. We exclude start-ups for which we could not identify at least one owner or the background history of the founder.[17] Also, we restrict the sample to founders with age between 20 and 60. One explanation for this is that individuals with more than 60 years old have the motivation to start a new firm only for spending the time occupied. In the other hand, individuals with less than 20 years old are too young to have long career histories. For those individuals, we only identify the last parent firm where the founder previously worked. Then, we track the parent firm performance, marketing expenses and R&D expenses for the last year (2006).

In total we end up with 10086 new firms in which 2193 are spin-offs. We define spin-offs as a new venture established in the same four-digit industry as the last parent firm. This sample allows us to study the impact of the accumulation and transfer of knowledge from the parent firm to start-ups, and more specifically to spin-offs. Table 1 presents the summary statistics of

[17] For the employees, the data include some cases in which the record changes in gender and year of birth.
We consider observations with multiple changes in the gender or year of birth to be errors, corresponding to individuals whose identification number was not recorded, or wrongly identified by the respondent. We drop individuals whose gender and year birth change in more than 70 percent of the total number of observations.

the data. In general, start-ups are small and employ approximately on average three employees. After the first three years, approximately 2385 firms fail (in which 437 were spin-offs), corresponding to a mortality rate of 24 percent. Approximately 43% of the startups of our sample tend to locate in the same region as the parent firm contrasting with the percentage of 71% in the case of spin-offs. Founders in our data are typically men (66%), with low education and with ages between 30 and 39 years old. On average, 63% of our founders have founded a new firm in a given year previous to 2007.

Parent firms in our data are in general older (on average have 15 years old) and larger (on average have 209 employees). Approximately 81% of all parent firms of our sample are more successful firms than the average firm in the same region and industry. Table 2 presents a short description of each variable and how they were constructed and Table 3 reports correlations for the variables entered into our linear regression model.

V. EMPIRICAL METHODOLOGY AND RESULTS

Survival

In this section, we present the estimates for the effect of market and technological knowledge on start-ups' performance and, more specifically, on spin-offs' performance. We start by evaluating the effect of knowledge on spin-off' survival, by using the following equation:

$$Y_{fsm} = \sum_{c=1}^{297} \alpha_c + \sum_{i=1}^{52} \gamma_i + \beta_1 R\&D_m + \beta_2 MKT_m + \delta_1 X_s + \delta_2 Z_f + \delta_3 T_m + \varepsilon_{fsmci} \quad (1)$$

where f denotes founder, s denotes start-up firm, m denotes last parent firm, i denotes the start-up industry and c is the start-up county.

Our dependent variable Y_{fsm} is a dummy variable equaling one if the start-up is still operating after 3 years (from 2007 to 2009), and 0 otherwise. In this regression, α_c controls for county fixed effects and γ_i are the two-digit industry fixed effects for 52 categories.

$R\&D_m$ and MKT_m are our variables of interest and represent, respectively, technological and market knowledge. Our variable of interest, $R\&D_m$, *Technological Knowledge* is a dummy variable equaling 1 if a given parent firm has, in 2006, a higher percentage of employees assigned to R&D than the average firm in the same industry, region and year, and 0 otherwise.[18] Our second variable of interest, MKT_m, *Market Knowledge* is also a dummy

[18] We also have tried to compute our results with an alternative variable for technological knowledge. However, the results were not what we were expecting and for this reason we present the results in Appendix A.1.

variable that equals 1 if a given parent firm invested more in marketing expenses in 2006 than the average firm in the same industry, region, and year and 0 otherwise. Marketing expenses is computed as total expenses in advertising, promotions and expenditures on sales divided by sales. We divide by sales to exclude the effect of firm size.

The variable X_s denotes the logarithm size of start-ups, measured as the logarithm of the total number of individuals in the employee records in the foundation year (2007).

We include also the following vector variables: founder characteristics Z_f and parent firm characteristics T_m. The founder characteristics vector includes: four indicator variables for the founder's age, partitioned at 20, 30, 40, and 50; a gender variable, which equals 1 for men, 0 for women; an "industry experience" (*Pindex*) variable which equals 1 for founders that previously work (in last parent firm) on the same four-digit industry digit code (meaning that the founder is a spin-off founder), and 0 otherwise; an education variable, which is taken to be "very low" for those never completing elementary school, "low" for those that attended junior high school, "medium" for those with a high school diploma or equivalent, and "high" for those reporting bachelor's degree or more advanced degree; an "entrepreneurial experience" variable that equals 1 if a founder have created a spin-off in a given year previous to 2007, and 0 if not; and a "regional experience" variable indicating if the start-up locates near to the parent firm and, in this sense, indicating if the founder has some regional experience or not. This variable

equals 1 for start-ups which locates on the same municipality of the parent firm, and 0 otherwise.

Finally, the parent firm characteristics vector includes the following variables: *ln(PAge)*, which is the logarithm of the number of years of the parent firm since creation until the year of start-up's foundation; *ln(PSize)*, which is the logarithm of the parent firm's number of employees in 2006; and performance, measured as a dummy variable equaling 1 if the parent firm performed better than similar firms in the same industry and region and 0 otherwise. Performance is evaluated as the ratio of net profit ("Resultado Líquido do Exercício") divided by total sales.

Accordingly with our theory, we expect that β_1 and β_2 to be both positive and statistic significant, meaning that the independent variables MKT_m and $R\&D_m$ (market and technological knowledge, respectively) have a positive impact on Y_{fsm} (start-up's survival). The estimated results are presented in Table 3 using OLS. Column (a) presents the results for survival including the characteristics of the founder and of the start-up, in column (b) we include the characteristics of the parent firm, in column (c) we include our variable of interest *Market knowledge*, in column (d) we include an interaction variable *Market*Pindex,* in column (e) we exclude the variables *Market knowledge* and *Market*Pindex* and include our second variable of interest *Technological Knowledge*, in column (f) we include to the previous regression an interaction variable *Technical*Pindex,* in column (h) we include all variables excluding the interaction variables (column (h) corresponds to our key regression (1)), and finally in column (f) we include the interaction variables.

As we can see from column (b), in general the probability of new firms' survival increases by 4,77% for founders with the same regional experience as the parent firm, 8,12% for highly educated founders, 5,29% if the founder is a men, and decreases for founders with entrepreneurial experience by 12,8%. Also, we observe that the higher is the initial number of employees of the start-ups, the higher is their probability of survival by 4,35%. All of the previous variables mentioned before shows a statistical significance at 1%. We can also infer from the results in column (b) that a parent firm older increases the probability of start-up survival by 2,27% while the size of the parent firm decreases their chances of survival. The parent firm's performance appears not being statistical significant and, in this sense, their impact on new firms' survival is insignificant.

Column (h) shows that both variables of interest are positive, nevertheless the coefficients are not statistical significant. These results suggest that founders that previous worked in parent firms with high levels of R&D and marketing expenses do not affect the survival prospects of new start-ups. That is, the impact of market and technological knowledge on new firms' survival appears not being significant.

In order to test the impact of knowledge accumulation on spin-offs relatively to non-spin-offs firms, we computed two interaction variables namely *Market*Pindex* and *Technical*Pindex,* where *Pindex*=1 means that the start-up is a spin-off *and Pindex*=0 is a non-spin-off firm. As we can notice from column (i), where we added the two interaction variables to our key regression (1), *Technical*Pindex* variable are statistical significant at 5%

showing that the higher is the percentage of people assigned in R&D over the total number of employees in the spin-off's parent firm, the more is the knowledge that founders can learn and transfer and, in this sense, the longer spin-offs can survive. In other words, a spin-off that comes from a parent firm that employs an average of more individuals allocated to R&D increases their survival prospects by 8,13%.

In the other hand, the variable *Market*Pindex* is not statistical significant meaning that market knowledge does not have a significant impact on spin-off's survival. This result contradicts our second and third hypotheses where we argued that the impact of market knowledge on spin-offs' performance is higher than the impact of technological knowledge. With these results we conclude that only technological knowledge has a significant impact on spin-offs' performance in terms of survival.

Growth

Next, we evaluate the effect of knowledge on spin-offs' growth as an alternative measure of performance, by using our key regression (1). In this case the dependent variable Y_{fsm} denotes start-ups' growth (employment growth rate) for firms that survived until 2009. This variable is the logarithm difference between the number of employees in 2009 and the initial number of employees. That is, this variable indicates the employment growth rate of start-ups from 2007 to 2009.

The estimated results on new venture growth are presented in Table 4 using OLS. Column (a) presents the results for growth including the

characteristics of the founder and of the start-up, in column (b) we include the characteristics of the parent firm, in column (c) we include our variable of interest *Market knowledge*, in column (d) we include an interaction variable *Market*Pindex,* in column (e) we exclude the variables *Market Knowledge* and *Market*Pindex* and include our second variable of interest *Technological Knowledge*, in column (f) we include to regression in column (e) an interaction variable *Technical*Pindex,* in column (h) we include all variables excluding the interaction variables (column (h) corresponds to our key regression (1)), and finally column (f) includes the interaction variables.

We can observe from column (a), that the variables *Age 30-39* and *Age 40-49* are statistical significant at 10%, meaning that founders with ages between 30 and 49 years old have a significant and positive impact in start-ups' employment growth rate by 4,45% and 4,53%, respectively. Also, we can notice that in general new venture growth increases by 9,99% for founders with industry experience and decreases by 7,62% for founders with entrepreneurial experience.

From column (b) we can infer that the parent firm's size is statistical significant at 1% increasing start-up's growth by 1,75%. The other characteristics of parent firms, age and performance, do not have an impact on start-up's employment growth rate.

As we can see from column (h), none of the variables of interest (market and technological knowledge) affect start-up's employment growth rate. From column (i), where we introduce the interaction variables *Market*Pindex* and *Technical*Pindex,* we observe that the while Market knowledge does not have

a significant impact on spin-offs' growth, Technical Knowledge is statistical significant at 10%. We can infer from the results that a spin-off that comes from a parent firm that employs an average of more individuals allocated to R&D increases their growth by 10,5% (both columns (f) or (i) presents the same result).

Once more, in opposite of what we were expecting, market knowledge does not have a significant impact on spin-off's growth as a measure performance.

VI. CONCLUSION

This paper uses Portuguese micro-level data on firms and founders to analyze the effect of knowledge accumulation/transfer on spin-offs' performance. We draw on two rich datasets: matched employer-employee database (Quadros de Pessoal) and a financial database (SCIE). This datasets give us detailed information on founders, their background history, parent firm's R&D investments and marketing expenses. With such comprehensive information, we evaluate what knowledge is more likely to affect spin-off's performance and what founder characteristics and parent firm characteristics affect new ventures performance. We measured spin-offs' performance in terms of survival and growth (employment growth rate).

However, the results of our research contradict in some points our hypothesis. We can conclude from our results that only technological knowledge learned and transferred by founders from parent firms has a significant impact on the performance of spin-offs in terms of survival and growth. This finding strongly refutes our third hypothesis where we argued that market knowledge has a higher impact on spin-off's performance than technological knowledge in the short-term.

The findings of our research have significant implications for policy-makers and academics. This is important for policy makers, who wish to enhance entrepreneurial activity and for researchers to understand which knowledge promotes successful ventures. A policy designed to foster high-quality new ventures should comprise parent firms. They are important sources of new high-quality firms, and our results point in the direction that

an environment conducive for investments in R&D in established firms has a higher potential for generating such high-quality entrepreneurs in the form of spin-offs from parent firms.

This study comes with some limitations. It was difficult to measure the different types of knowledge and to find good proxies that truly represent which the two kinds of knowledge. We used the best measures available in our data. Since our results contradict in some points our theory, we believe that we should compute more adequate variables in order to realize this analysis.

The second limitation of our study comes from our sample. We also believe that our results it wasn't completely what we were expecting since we have a reduced number of new firms in our sample, not allowing us to perform consistent measures.

Future research should test the impact of organizational knowledge on spin-offs' performance. Since parents' organizational routines, blueprints, strategies and organizational forms are also transferred to the new firms. It would be good to know in what extent this kind of knowledge creates an advantageous position for spin-offs over the other start-ups and if this knowledge has or not a bigger impact on spin-offs performance relatively to market and technological knowledge.

VII. BIBLIOGRAPHY

Agarwal, Rajshree, Raj Echambadi, April Mitchell Franco, M. B. Sarkar (2004). Knowledge transfer through inheritance: Spin-out generation, development, and survival. The Academy of Management Journal, 501-522.

Aldrich, Howard E., Gabrielle Wiedenmayer (1993). From traits to rates: An ecological perspective on organizational founding. Advances in Entrepreneurship, Firm Emergence and Growth (1), 145-195.

Argote, L. and Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. Organizational behavior and human decision processes 82 (1), 150-169.

Argote, L. and Ingram, P. and Levine, J.M. and Moreland, R.L. (2000). Knowledge transfer in organizations: Learning from the experience of others. Organizational Behavior and Human Decision Processes 82 (1), 1-8.

Andersson, Martin, Apostolos Baltzopoulos and Hans Lööf (2011). R&D strategies and Entrepreneurial Spawning. Research Policy.

Arrow, K. J. (1962). The economic implications of learning by doing. Review of Economic Studies 29 (80), 155- 173.

Astebro, T. and I. Bernhardt (2005). The winners curse of human capital. Small Business Economics 24, 63-78.

Audretsch, David B., Max Keilbach, and Erik E. Lehmann (2006). Entrepreneurship and Economic Growth. New York: Oxford University Press.

Balconi, M. and Fontana, R. (2011). Entry and innovation: an analysis of the fabless semiconductor business. Journal Small Business Economics 37 (1), 87-106.

Baptista, Rui, Murat Karaoz and Joana Mendonça (2007). Entrepreneurial Backgrounds, Human Capital and Start-up Success. Jena Economic Research Papers.

Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of management 17 (1), 99-120.

Bazzazian, Navid (2012). Selection vs. Learning in Employee Entrepreneurship, HEC-Paris.

Biggadike, E.R. and Harvard University. Graduate School of Business Administration. Division of Research (1976). Corporate Diversification: Entry, Strategy, and Performance.

Buenstorf, G., Klepper, S. (2009). Heritage and agglomeration: The Akron tire cluster revisited. Economic Journal 119 (537), 705-733.

Burt, R. S. (2000). The network structure of social capital. Research in Organzational Behavior 22, 345-423.

Burton, M. Diane, Jesper B. Sørensen and Christine M. Beckman (2002). Coming From Good Stock: Career Histories and New Venture Formation. Cornell University ILR School.

Carroll, Glenn R. (1984). Organizational ecology. Annual Review of Sociology 10, 71-93.

Carroll, G. R, Bigelow, L. S., Seidel, M. L., & Tsai, L. B. (1996). The fates of de novo and de alio producers in the American automobile industry 1885-1981. Strategic Management Journal 17, 117-137.

Chatterji AK. (2009). Spawned with a silver spoon? Entrepreneurial performance and innovation in the medical device industry. Strategic Management Journal 30(2), 185-206.

Cohen, W.M. and Levinthal, D.A. (1990). Absorptive capacity: a new perspective on learning and innovation. Administrative science quarterly, 128-152

Colombo M, Delmastro M, Girilli L. (2004). Entrepreneurs' human capital and the start-up size of new technology-based firms. International Journal of Industrial Organization 22, 1183-1211.

Cooper, Arnold C. (1985). The role of incubator organizations in the founding of growth-oriented firms. Journal of Business Venturing 1, 75-86.

Dahl, M.S. and Reichstein, T. (2007). Are you experienced? Prior experience and the survival of new organizations. Industry and Innovation 14 (5), 497-511.

Dahl, Michael S. ,and Toke Reichstein (2010). Heritage of Employee Startups: Founder Experiences and Survival of New Firms.

Dahl, Michael S., Christian Ø.R. Pedersen and Bent Dalum. Entrepreneurial Founder Effects in the Growth of Regional Clusters: How Early Success is a Key Determinant. *DRUID Working Paper.*

Dahl, Michael S., and Toke Reichstein (2006). Heritage and Survival of Spin-offs: Quality of Parents and Parent-Tenure of founders. Academy of Management Annual Meeting, Atlanta GA.

Dahl, Michael S., and Toke Reichstein (2005). Organizational Routines and the Survival of New Firms. X Conference Dynamics of industry and innovation: Organizations, networks and systems, Danish Research Unit for Industrial Dynamics.

Dobrev, S.D. and Barnett, W.P. (2005). Organizational roles and transition to entrepreneurship. The Academy of Management Journal, 433-449.

Elfenbein, Daniel W., Barton H. Hamilton and Todd R. Zenger (2010). The Small Firm Effect and the Entrepreneurial Spawning of Scientists and Engineers. Journal Management Science 56 (4), 659-681.

Eriksson, T. and Moritz Kuhn, J. (2006). Firm spin-offs in Denmark 1981-2000 - patterns of entry and exit. International Journal of Industrial Organization 24 (5), 1021-1040.

Ferreira, M. P., Tavares, A. T., Hesterly W., Armagan S. (2006). Network and firm antecedents of spin-offs: Motherhooding spin-offs. Faculdade de Economia, Universidade do Porto.

Franco, A.M. and Filson, D. (2006). Spin-outs: knowledge diffusion through employee mobility. The RAND Journal of Economics 37 (4), 841-860.

Garicano, Luis, and Thomas N. Hubbard (2003). Firms' boundaries and the division of labor: Empirical strategies'. Journal of the European Economic Association 1, 495-502.

Garvin, David A. (1983). Spin-offs and the New Firm Formation Process. California Management Review 25 (2), 3-20.

Gompers, Paul, Josh Lerner and David Scharfstein (2005). Entrepreneurial Spawning: Public Corporations and the Genesis of New Ventures, 1986 to 1999. The Journal of Finance 60 (2), 577-614.

Haldin-Herrgard, T. (2000). Difficulties in diffusion of tacit knowledge in organizations. Journal of Intellectual capital 1 (4), 357-367.

Hannan, Michael T., John Freeman (1986). Where do organizational forms come from? Sociological Forum 1, 50-72.

Hansen, M. (1999). The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. Administrative Science Quarterly 44, 82–111.

Helfat, C.E. and Lieberman, M.B. (2002). The birth of capabilities: market entry and the importance of pre-history. Industrial and Corporate Change 11 (4), 725-760.

Henderson, R. (1993). Underinvestment and incompetence as responses to radical innovation—evidence from the photolithographic alignment equipment industry. The Rand Journal of Economics 24 (2), 248–270.

Higgins, M., & Gulati, R. (2003). Getting off to a good start: The effects of the upper echelon affiliations on under writer prestige. Organization Science 14, 244-263.

Huber, G.P. (1991). Organizational learning: The contributing processes and the literatures. Organization science, 88-115.

Klepper, S., Sleeper, S. (2005). Entry by spinoffs. Management Science, 1291-1306.

Klepper, S. and Thompson, P. (2005). Spinoff entry in high-tech industries: motives and consequences. Economic Perspectives on Innovation, Cambridge University Press 6, 187-218.

Klepper, S. (2007). Disagreements, spinoffs, and the evolution of Detroit as the capital of the US automobile industry. Journal Management Science 53 (4), 616-631.

Klepper. S., and P. Thompson (2006). Intra-Industry Spin-offs. Florida International University, Mimeo.

Klepper, S. (2002). The capabilities of new firms and the evolution of the US automobile industry. Industrial and corporate change 11 (4), 645-666.

Klepper, S. (2001). Employee startups in high-tech industries. Industrial and Corporate Change 10 (3), 639-674.

Klepper, Steven (2009). Silicon Valley – A Chip off the Old Detroit Block. In David Audretsch and Robert Strom (eds.), Entrepreneurship, Growth, and Public Policy. Cambridge: Cambridge University Press.

Koster, Sierdjan (2004). Spin-off firms and individual start-ups. Are they really different? Paper prepared for the 44th ERSA conference, Porto, pp. 25-29.

Koster S. & L.J.G.v. Wissen (2003). Inherited resources and company resources as basis for new firm formation. A taxonomy of founding types: start-ups, spin-outs, and spin-offs.

McGrath, J. E. and Argote, L. (2001). Group processes in organizational contexts. Blackwell handbook of social psychology: Group processes, 603-627.

Nelson, R. R., & Winter, S. G. (1982). An evolutionary theory of economic change. Belknap press.

Nonaka, Ikujiro (1994). A dynamic theory of organizational knowledge creation. Organizational Science 5 (1), 14-37.

Osterloh, M. and Frey, B.S. (2000). Motivation, knowledge transfer, and organizational forms. Organization Science 11 (5), 538-550.

Parker, Simon C. (2009). Why do small firms produce the entrepreneurs? The Journal of Socio-Economics 38, (3), 484-494.

Phillips, D.J. (2002). A genealogical approach to organizational life chances: The parent-progeny transfer among Silicon Valley law firms, 1946-1996. Administrative Science Quarterly, 474-506.

Shane, S. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. Organization science, 448-469.

Sørensen, Jesper B. and Damon J Phillips (2004). Do small firms produce better entrepreneurs? Presented at the Harvard Business School Entrepreneurship Conference, October.

Sorenson, O. (2003). Social Networks and Industrial Geography. Journal of Evolutionary Economics, 13(5), 513-527.

Thorndike, E. K., (1906). The Principles of teaching. A. G. Seiler.

Tsuchiya, R. (2006). The Effect of Prior Employer Firm Size on Entrepreneurs' Skills. Discussion Papers, Graduate School of Economics, Hitotsubashi University.

Tushman, M.L. and Anderson, P. (1986). Technological discontinuities and organizational environments. Administrative science quarterly, 439-465

Uzunca, Bilgehan (2011). Comparative Advantages of Spin-off Firms: An Evolutionary Perspective. Journal of Technology Management & Innovation 6 (4), 80-92.

Zander, U. and Kogut, B. (1995). Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. Organization Science 6, 76–92.

Wiggins, S. N. (1995). Entrepreneurial enterprises, endogenous ownership, and the limits to firm size. Economic Inquiry 33, 54-69.

Van Wijk, R. and Jansen, J.J.P. and Lyles, M.A. (2008). Inter-and Intra-Organizational Knowledge Transfer: A Meta-Analytic Review and Assessment of its Antecedents and Consequences. Journal of Management Studies 45 (4), 830-853.

Tabela 1: Descriptive Statistics

	Sample (All start-ups)			Spin-offs (Pindex=1)			Non Sin-offs (Pindex=0)		
Variable	**Obs.**	**Mean**	**Std Dev.**	**Obs.**	**Mean**	**Std Dev.**	**Obs.**	**Mean**	**Std Dev.**
Panel A - Start-up characteristics									
Size	10086	3,43	6,65	2193	4,60	8,94	6879	3,18	6,15
Survival	10086	0,76	0,42	2193	0,80	0,40	6879	0,80	0,40
Growth	10086	0,11	0,66	2193	0,15	0,66	6879	0,10	0,66
Panel B - Founder characteristics									
Age 20-29	10086	0,35	0,48	2193	0,30	0,46	6879	0,36	0,48
Age 30-39	10086	0,37	0,48	2193	0,41	0,49	6879	0,37	0,48
Age 40-49	10086	0,20	0,40	2193	0,22	0,41	6879	0,19	0,39
Age 50-60	10086	0,09	0,28	2193	0,08	0,27	6879	0,08	0,28
Very Low Education	10020	0,11	0,32	2187	0,17	0,38	6846	0,09	0,29
Low Education	10020	0,36	0,48	2187	0,48	0,50	6846	0,34	0,47
Medium Education	10020	0,30	0,46	2187	0,24	0,42	6846	0,32	0,47
High Education	10020	0,22	0,42	2187	0,12	0,32	6846	0,25	0,43
Gender (Men)	10086	0,66	0,47	2193	0,71	0,46	6879	0,65	0,48
Pindex	9072	0,24	0,43	2193	1	0	6879	0	0
Regional experience	9072	0,43	0,50	2193	0,71	0,45	6879	0,34	0,47
Entrepreneurial experience	9072	0,63	0,48	2193	0,63	0,48	6879	0,63	0,48
Panel C - Parent firm characteristics									
PAge	6120	15,82	19,24	2193	11,05	11,13	4076	18,39	22
PSize	6269	209,4	1129,8	2193	25,24	196,94	4076	308,44	1383,6
Performance	4918	0,81	0,40	1615	0,85	0,36	3303	0,78	0,41
Variables of interest									
Maket knowledge	4918	0,17	0,37	1615	0,13	0,34	3303	0,19	0,39
Technological knowledge	5007	0,16	0,36	1642	0,20	0,40	3365	0,14	0,35

Note: The table reports some descriptive statistics for our variables.

Tabela 2: Variables Description

Variable	Description
Panel A - Start-up characteristics	
Size	*Size* is the start-up's initial number of employees, that is, the total number of individuals in the employee records in the foundation year (2007).
Survival	*Survival* is na indicator variable equaling 1 for start-ups that survived their first 3 years (since foundation year – 2007 – until 2009) and 0 otherwise. Firms are classified as non-survivors if they do not appear in the database in following years.
Growth	This varable denotes the employment growth rate from 2007 to 2009 for start-ups that survived until 2009. This variable is computed as the logarithm difference between the number of employees in 2009 and the initial number of employees (in 2007).
Panel B - Founder characteristics	
Age	This variable is coded in years in the database. We define four categorical variables: *Age 20-29* is coded one for individuals with age between 20 and 29; *Age 30-39* is coded one for individuals with age between 30 and 39; *Age 40-49* is coded one for individuals with age between 40 and 49; *Age 50-60* is coded one for individuals with age between 50 and 60.
Education	This variable is measured with four categorical variables: *high education* is a dummy variable equaling one for founders with bachelors, masters or doctoral degrees; *medium education* is a dummy variable equaling one for individuals reporting a high school diploma or vocational school degree; *low education* is a dummy variable equaling one for individuals that attended junior high school; and *very low education* is a dummy variable equaling one for individuals who never attended or completed the elementary school.
Gender (Men)	*Gender* is a dummy variable equaling 1 for men and 0 for women.
Industry experience	Industry experience (*Pindex*) is an indicator variable equaling 1 for founders that have previously work on the same four-digit industry code and 0 otherwise. In other words, this variable equals 1 if the new firm is a spin-off and 0 otherwise.
Regional experience	Regional is a variable that indicates if the start-up locates near to the parent firm. Equals 1 for spin-offs which locates on the same region (municipality) of the parent firm, and 0 otherwise.
Entrepreneurial experience	This variable equals 1 if a founder have created a start-up in a given year previous to 2007 and 0 if not. We can distinguish two categories of entrepreneurs: "novice entrepreneurs", who have not previously established a firm, but who do have previous labor experience, and "habitual entrepreneurs", who have both previous entrepreneurial and labor experience.
Panel C - Parent firm characteristics	
PAge	This variable denotes the age of the parent firm. This variable is computed the total number of years of the parent firm since creation until 2006.
PSize	This variable indicates the parent firm's size. The variable is computed as the the total number of employees in 2006 (the previous year of start-up's foundation).
Performance	This variable equals 1 if the parent firm has a higher performance ratio than the average per region and industry and 0 otherwise. This performance ratio consists in the net profit of the year ("Resultado Líquido do Exercício") divided by sales in 2006.
Variables of interest	
Technical knowledge	This variable is a dummy variable equaling 1 if a given parent firm has, in 2006, a percentage of employees assigned to R&D over the total number of employees in the company more or equal than an average of this percentage per industry and region, and 0 otherwise.
Maket knowledge	We define this variable as the marketing expenses (in advertising, promotions, expenditures on sales, etc) of the parent firm in 2006 (previous year of spin-off's creation). To compute this variable, we divide marketing expenses by sales in order to exclude the effect of the parent firm size. Next, we simply compute an average by region and industry of marketing expenses of all parent firms in our sample in 2006. If a parent firm has conducted market expenses above or equals this average, the variable equals 1, if not equals 0.

Tabela 3: Correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Panel A																				
1 Size	1																			
2 Survival	0.0534	1																		
3 Growth	-0.3677	0.1194	1																	
Panel B																				
4 Age 20-29	-0.0184	-0.0518	-0.0096	1																
5 Age 30-39	0.0117	0.0284	0.0029	-0.5759	1															
6 Age 40-49	0.0028	0.0252	0.0081	-0.3444	-0.4121	1														
7 Age 50-60	0.0070	0.0011	-0.0005	-0.1895	-0.2267	-0.1356	1													
8 Very Low Education	0.0828	-0.0137	0.0160	-0.1559	-0.0628	0.1282	0.2077	1												
9 Low Education	0.0686	0.0001	-0.0093	0.0168	-0.0366	0.0294	-0.0062	-0.2833	1											
10 Medium Education	-0.0577	-0.0215	-0.0224	0.1155	-0.0278	-0.0461	-0.0867	-0.2332	-0.5315	1										
11 High Education	-0.0834	0.0358	0.0249	-0.0316	0.1277	-0.0845	-0.0563	-0.1723	-0.3927	-0.3233	1									
12 Gender (Men)	0.0675	0.0372	0.0005	0.0021	-0.0226	0.0143	0.0173	0.0579	0.0896	-0.0449	-0.1045	1								
13 Pindex	0.1750	0.0289	0.0243	-0.0473	0.0037	0.0444	0.0106	0.1079	0.1078	-0.0971	-0.1060	0.0560	1							
14 Regional experience	0.0874	0.0632	-0.0095	-0.0585	-0.0073	0.0454	0.0509	0.0729	0.1096	-0.0802	-0.1000	-0.0134	0.1171	1						
15 Entrepreneurial experience	0.0139	-0.1389	-0.0566	-0.0116	-0.0092	0.0216	0.0053	0.0021	0.0208	-0.0038	-0.0230	0.0395	0.0324	0.0552	1					
Panel C																				
16 PAge	-0.0802	-0.0149	0.0017	-0.0275	-0.0255	0.0443	0.0304	-0.0237	-0.0435	0.0225	0.0464	-0.0166	-0.1990	-0.1421	-0.0252	1				
17 PSize	-0.0611	-0.0514	-0.0096	0.0702	-0.0344	-0.0206	-0.0305	-0.0323	-0.0358	0.0505	0.0111	-0.0487	-0.1192	-0.1407	-0.0030	0.3238	1			
18 Performance	0.0665	-0.0111	0.0039	0.0168	0.0164	-0.0235	-0.0257	0.0321	0.0523	-0.0473	-0.0351	0.0435	0.0800	0.0250	-0.0046	0.0467	0.0743	1		
Variables of interest																				
20 Maket knowledge	-0.0398	0.0008	-0.0050	0.0375	-0.0137	-0.0089	-0.0287	-0.0701	-0.0317	0.0595	0.0256	-0.0418	-0.0673	-0.0507	-0.0282	0.1056	0.0618	-0.0305	1	
19 Technological knowledge	0.0220	-0.0025	-0.0174	-0.0109	-0.0084	0.0199	0.0051	0.0580	0.0329	-0.0088	-0.0766	0.0229	0.0734	0.0562	-0.0175	0.0242	0.0113	0.0654	-0.0122	1

Note: The table presents the correlations between our variables.

Tabela 4: The impact of knowledge on Spin-offs' Survival

Variables	(a)	(b)	(c)	(d)	(e)	(f)	(h)	(i)
Panel A								
ln(Size)	0.0341***	0.0435***	0.0436***	0.0436***	0.0435***	0.0434***	0.0436***	0.0436***
	(0.00624)	(0.00852)	(0.00852)	(0.00852)	(0.00852)	(0.00853)	(0.00852)	(0.00853)
Panel B								
Age 20-29	-0.0545***	-0.0191	-0.0193	-0.0191	-0.0190	-0.0190	-0.0193	-0.0191
	(0.0171)	(0.0276)	(0.0276)	(0.0276)	(0.0276)	(0.0275)	(0.0276)	(0.0275)
Age 30-39	-0.0203	0.0182	0.0181	0.0182	0.0181	0.0186	0.0180	0.0186
	(0.0167)	(0.0267)	(0.0267)	(0.0267)	(0.0267)	(0.0267)	(0.0267)	(0.0267)
Age 40-49	-0.00827	0.0304	0.0302	0.0301	0.0304	0.0302	0.0301	0.0299
	(0.0174)	(0.0277)	(0.0277)	(0.0277)	(0.0277)	(0.0276)	(0.0277)	(0.0276)
Low Education	0.00464	0.0337	0.0331	0.0333	0.0339	0.0334	0.0332	0.0329
	(0.0153)	(0.0223)	(0.0223)	(0.0223)	(0.0223)	(0.0223)	(0.0223)	(0.0223)
Medium Education	0.0132	0.0386	0.0375	0.0378	0.0388	0.0393*	0.0376	0.0385
	(0.0164)	(0.0238)	(0.0238)	(0.0238)	(0.0238)	(0.0238)	(0.0238)	(0.0238)
High Education	0.0491***	0.0812***	0.0801***	0.0803***	0.0815***	0.0816***	0.0804***	0.0806***
	(0.0183)	(0.0269)	(0.0269)	(0.0269)	(0.0269)	(0.0269)	(0.0269)	(0.0269)
Gender (Men)	0.0322***	0.0529***	0.0530***	0.0533***	0.0528***	0.0529***	0.0529***	0.0532***
	(0.00973)	(0.0147)	(0.0147)	(0.0147)	(0.0147)	(0.0147)	(0.0147)	(0.0147)
Pindex	0.00739	0.0163	0.0164	0.0205	0.0159	0.00304	0.0161	0.00710
	(0.0111)	(0.0145)	(0.0145)	(0.0154)	(0.0145)	(0.0156)	(0.0145)	(0.0165)
Regional experience	-0.000654	0.0477***	0.0477***	0.0473***	0.0475***	0.0486***	0.0475***	0.0482***
	(0.00972)	(0.0142)	(0.0142)	(0.0142)	(0.0142)	(0.0142)	(0.0142)	(0.0142)
Entrepreneurial experience	-0.127***	-0.128***	-0.128***	-0.128***	-0.128***	-0.128***	-0.128***	-0.128***
	(0.00845)	(0.0124)	(0.0124)	(0.0124)	(0.0124)	(0.0124)	(0.0124)	(0.0124)
Panel C								
ln(PAge)		0.0227***	0.0228***	0.0225***	0.0228***	0.0234***	0.0228***	0.0231***
		(0.00735)	(0.00735)	(0.00737)	(0.00736)	(0.00736)	(0.00735)	(0.00738)
ln(PSize)		-0.0188***	-0.0192***	-0.0192***	-0.0189***	-0.0189***	-0.0192***	-0.0193***
		(0.00435)	(0.00438)	(0.00438)	(0.00436)	(0.00436)	(0.00439)	(0.00438)
Performance		0.000986	0.00132	0.00146	0.000619	0.000543	0.000949	0.00102
		(0.0159)	(0.0159)	(0.0159)	(0.0159)	(0.0159)	(0.0159)	(0.0159)
Variables of interest								
Market knowledge			0.0127	0.0202			0.0127	0.0202
			(0.0171)	(0.0198)			(0.0171)	(0.0198)
Market*Pindex				-0.0284				-0.0270
				(0.0387)				(0.0385)
Technological knowledge					0.00847	-0.0210	0.00862	-0.0210
					(0.0217)	(0.0262)	(0.0217)	(0.0262)
Technical*Pindex						0.0814**		0.0813**
						(0.0363)		(0.0363)
Constant	0.911***	1.245***	1.236***	1.231***	1.248***	1.225***	1.239***	1.212***
	(0.0703)	(0.310)	(0.310)	(0.310)	(0.310)	(0.307)	(0.311)	(0.308)
Observations	9033	4809	4809	4809	4809	4809	4809	4809
Adjusted R-squared	0.049	0.057	0.056	0.056	0.056	0.057	0.056	0.057

Note: The table reports estimated coefficients for our key equation (1) present in column (h), and for other regressions. The dependent variable is three year survival (1 if the start-up survived, 0 if not). County and industry fixed effects are included but not reported. The variables Age 50-60 and Very Low Education are the omitted variables. Robust standard errors are in parentheses and the number of observations is presented below. *** denotes statistical significance at 1%, ** significance at 5%, * significance at 10%.

Tabela 5: The impact of knowledge on Spin-offs' Growth

Variables	(a)	(b)	(c)	(d)	(e)	(f)	(h)	(i)
Panel A								
ln(Size)	-0.382***	-0.395***	-0.395***	-0.395***	-0.395***	-0.395***	-0.395***	-0.395***
	(0.0142)	(0.0200)	(0.0200)	(0.0200)	(0.0200)	(0.0200)	(0.0200)	(0.0200)
Panel B								
Age 20-29	0.0218	-0.0336	-0.0333	-0.0335	-0.0336	-0.0336	-0.0333	-0.0335
	(0.0260)	(0.0424)	(0.0424)	(0.0424)	(0.0424)	(0.0424)	(0.0424)	(0.0424)
Age 30-39	0.0445*	-0.00560	-0.00550	-0.00555	-0.00566	-0.00503	-0.00556	-0.00499
	(0.0256)	(0.0411)	(0.0412)	(0.0411)	(0.0411)	(0.0411)	(0.0412)	(0.0411)
Age 40-49	0.0453*	0.00839	0.00871	0.00878	0.00835	0.00818	0.00867	0.00857
	(0.0267)	(0.0425)	(0.0426)	(0.0426)	(0.0425)	(0.0425)	(0.0426)	(0.0426)
Low Education	-0.0221	-0.0490	-0.0481	-0.0483	-0.0489	-0.0495	-0.0480	-0.0488
	(0.0226)	(0.0332)	(0.0332)	(0.0332)	(0.0332)	(0.0332)	(0.0332)	(0.0332)
Medium Education	-0.0159	-0.0432	-0.0416	-0.0419	-0.0431	-0.0423	-0.0415	-0.0411
	(0.0250)	(0.0366)	(0.0367)	(0.0368)	(0.0366)	(0.0366)	(0.0367)	(0.0368)
High Education	0.0217	0.00414	0.00569	0.00555	0.00438	0.00452	0.00591	0.00588
	(0.0284)	(0.0419)	(0.0420)	(0.0420)	(0.0419)	(0.0419)	(0.0420)	(0.0420)
Gender (Men)	0.0213	0.0175	0.0174	0.0171	0.0173	0.0175	0.0172	0.0172
	(0.0144)	(0.0217)	(0.0217)	(0.0217)	(0.0217)	(0.0217)	(0.0217)	(0.0217)
Pindex	0.0999***	0.123***	0.123***	0.119***	0.123***	0.106***	0.123***	0.102***
	(0.0172)	(0.0235)	(0.0236)	(0.0254)	(0.0234)	(0.0245)	(0.0234)	(0.0263)
Regional experience	0.0190	0.0301	0.0301	0.0305	0.0299	0.0314	0.0299	0.0318
	(0.0145)	(0.0210)	(0.0210)	(0.0211)	(0.0211)	(0.0210)	(0.0211)	(0.0211)
Entrepreneurial experience	-0.0762***	-0.0898***	-0.0901***	-0.0899***	-0.0897***	-0.0891***	-0.0900***	-0.0892***
	(0.0140)	(0.0202)	(0.0202)	(0.0203)	(0.0202)	(0.0202)	(0.0203)	(0.0203)
Panel C								
ln(PAge)		-0.0168	-0.0168	-0.0166	-0.0168	-0.0160	-0.0168	-0.0158
		(0.0109)	(0.0109)	(0.0109)	(0.0109)	(0.0109)	(0.0109)	(0.0109)
ln(PSize)		0.0175***	0.0179***	0.0180***	0.0174***	0.0175***	0.0179***	0.0180***
		(0.00627)	(0.00633)	(0.00633)	(0.00626)	(0.00626)	(0.00632)	(0.00632)
Performance		0.0136	0.0132	0.0130	0.0133	0.0132	0.0128	0.0126
		(0.0239)	(0.0239)	(0.0239)	(0.0239)	(0.0239)	(0.0239)	(0.0239)
Variables of interest								
Market knowledge			-0.0179	-0.0252			-0.0178	-0.0252
			(0.0248)	(0.0285)			(0.0248)	(0.0285)
Market*Pindex				0.0273				0.0291
				(0.0569)				(0.0569)
Technological knowledge					0.00784	-0.0302	0.00763	-0.0303
					(0.0346)	(0.0373)	(0.0346)	(0.0373)
Technical*Pindex						0.105*		0.105*
						(0.0574)		(0.0574)
Constant	-1.522***	0.197	0.209	0.214	0.200	0.170	0.212	0.187
	(0.452)	(0.378)	(0.379)	(0.380)	(0.378)	(0.377)	(0.380)	(0.379)
Observations	9033	4809	4809	4809	4809	4809	4809	4809
Adjusted R-squared	0.187	0.181	0.181	0.181	0.181	0.181	0.181	0.181

Note: The table reports estimated coefficients for our key equation (1) present in column (h), and for other regressions. The dependent variable is the employment growth rate of start-ups from 2007 to 2009. County and industry fixed effects are included but not reported. The variables Age 50-60 and Very Low Education are the omitted variables. Robust standard errors are in parentheses and the number of observations is presented below. *** denotes statistical significance at 1%, ** significance at 5%, * significance at 10%.

APPENDIX

A.1 ALTERNATIVE VARIABLE FOR TECHNOLOGICAL KNOWLEDGE

The alternative variable for technological knowledge consists in the R&D investments of the parent firm in 2006 (includes expenses on research and development and industrial property), divided by sales. We divide R&D investments by sales in order to exclude the effect of the parent firm size. Then, we compute an average of R&D investments per region and industry of all parent firms in our sample. If a given parent firm have invested more or a value equal to this average in 2006, the variable equals 1, if not equals 0.

As we can notice from Tables 6 and 7, using this alternative variable for technological knowledge leading us to conclude that technological knowledge do not have impact on spin-offs's performance both in terms of survival and growth, since the interaction variable *Technical*Pindex* is not statistical significant.

Tabela 6: The impact of knowledge on Spin-offs' Survival

Variables	(a)	(b)	(c)	(d)
Panel A				
ln(Size)	0.0436***	0.0435***	0.0438***	0.0437***
	(0.00852)	(0.00852)	(0.00852)	(0.00852)
Panel B				
Age 20-29	-0.0185	-0.0184	-0.0188	-0.0185
	(0.0276)	(0.0276)	(0.0276)	(0.0276)
Age 30-39	0.0187	0.0188	0.0186	0.0187
	(0.0267)	(0.0267)	(0.0267)	(0.0267)
Age 40-49	0.0305	0.0306	0.0303	0.0303
	(0.0277)	(0.0277)	(0.0277)	(0.0277)
Low Education	0.0340	0.0340	0.0334	0.0336
	(0.0223)	(0.0223)	(0.0223)	(0.0223)
Medium Education	0.0387	0.0386	0.0376	0.0378
	(0.0238)	(0.0238)	(0.0238)	(0.0238)
High Education	0.0807***	0.0809***	0.0797***	0.0800***
	(0.0269)	(0.0269)	(0.0269)	(0.0269)
Gender (Men)	0.0528***	0.0528***	0.0529***	0.0532***
	(0.0147)	(0.0147)	(0.0147)	(0.0147)
Pindex	0.0165	0.0179	0.0166	0.0219
	(0.0145)	(0.0147)	(0.0145)	(0.0155)
Regional experience	0.0475***	0.0473***	0.0475***	0.0469***
	(0.0142)	(0.0142)	(0.0142)	(0.0142)
Entrepreneurial experience	-0.128***	-0.128***	-0.128***	-0.128***
	(0.0124)	(0.0124)	(0.0124)	(0.0124)
Panel C				
ln(PAge)	0.0229***	0.0229***	0.0230***	0.0227***
	(0.00736)	(0.00737)	(0.00736)	(0.00739)
ln(PSize)	-0.0191***	-0.0192***	-0.0194***	-0.0195***
	(0.00438)	(0.00438)	(0.00441)	(0.00440)
Performance	0.000751	0.000805	0.00108	0.00127
	(0.0159)	(0.0159)	(0.0159)	(0.0159)
Variables of interest				
Market knowledge			0.0121	0.0191
			(0.0172)	(0.0199)
Market*Pindex				-0.0272
				(0.0387)
Technological knowledge	0.0233	0.0320	0.0224	0.0300
	(0.0302)	(0.0331)	(0.0303)	(0.0331)
Technical*Pindex		-0.0431		-0.0402
		(0.0795)		(0.0797)
Constant	1.244***	1.244***	1.236***	1.231***
	(0.310)	(0.310)	(0.311)	(0.311)
Observations	4809	4809	4809	4809
Adjusted R-squared	0.057	0.056	0.056	0.056

Note: The table reports estimated coefficients for our key equation (1) and other regressions, but using an alternative measure for technological knowledge. The dependent variable is three year survival (1 if the start-up survived, 0 if not). County and industry fixed effects are included but not reported. The variables Age 50-60 and Very Low Education are the omitted variables. Robust standard errors are in parentheses and the number of observations is presented below. *** denotes statistical significance at 1%, ** significance at 5%, * significance at 10%.

Tabela 7: The impact of knowledge on Spin-offs' Growth

Variables	(a)	(b)	(c)	(d)
Panel A				
ln(Size)	-0.395***	-0.395***	-0.395***	-0.395***
	(0.0200)	(0.0200)	(0.0200)	(0.0200)
Panel B				
Age 20-29	-0.0341	-0.0344	-0.0338	-0.0342
	(0.0424)	(0.0424)	(0.0424)	(0.0425)
Age 30-39	-0.00601	-0.00624	-0.00589	-0.00614
	(0.0411)	(0.0411)	(0.0412)	(0.0412)
Age 40-49	0.00829	0.00816	0.00861	0.00855
	(0.0425)	(0.0425)	(0.0426)	(0.0426)
Low Education	-0.0492	-0.0493	-0.0483	-0.0486
	(0.0332)	(0.0332)	(0.0332)	(0.0333)
Medium Education	-0.0433	-0.0431	-0.0417	-0.0419
	(0.0366)	(0.0366)	(0.0367)	(0.0368)
High Education	0.00458	0.00423	0.00606	0.00555
	(0.0420)	(0.0420)	(0.0420)	(0.0421)
Gender (Men)	0.0176	0.0175	0.0175	0.0172
	(0.0217)	(0.0217)	(0.0217)	(0.0217)
Pindex	0.123***	0.120***	0.123***	0.117***
	(0.0236)	(0.0238)	(0.0236)	(0.0256)
Regional experience	0.0302	0.0306	0.0302	0.0310
	(0.0210)	(0.0211)	(0.0210)	(0.0211)
Entrepreneurial experience	-0.0900***	-0.0901***	-0.0903***	-0.0902***
	(0.0203)	(0.0203)	(0.0203)	(0.0203)
Panel C				
ln(PAge)	-0.0169	-0.0169	-0.0170	-0.0167
	(0.0109)	(0.0109)	(0.0109)	(0.0109)
ln(PSize)	0.0177***	0.0178***	0.0182***	0.0183***
	(0.00630)	(0.00630)	(0.00635)	(0.00635)
Performance	0.0138	0.0137	0.0134	0.0131
	(0.0239)	(0.0239)	(0.0239)	(0.0238)
Variables of interest				
Market knowledge			-0.0175	-0.0239
			(0.0249)	(0.0286)
Market*Pindex				0.0257
				(0.0570)
Technological knowledge	-0.0196	-0.0353	-0.0183	-0.0328
	(0.0466)	(0.0520)	(0.0467)	(0.0523)
Technical*Pindex		0.0785		0.0750
		(0.115)		(0.116)
Constant	0.198	0.198	0.209	0.214
	(0.377)	(0.377)	(0.379)	(0.379)
Observations	4809	4809	4809	4809
Adjusted R-squared	0.181	0.181	0.181	0.180

Note: The table reports estimated coefficients for our key equation (1) and other regressions, but using the alternative measure for technological knowledge. The dependent variable is the employment growth rate of start-ups from 2007 to 2009. County and industry fixed effects are included but not reported. The variables Age 50-60 and Very Low Education are the omitted variables. Robust standard errors are in parentheses and the number of observations is presented below. *** denotes statistical significance at 1%, ** significance at 5%, * significance at 10%.